Newsletter for March 2024

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The Head of an Anthro

By Zennith | March 21, 2024

The Head of an Anthro
Chapter 1

Watch on YouTube: https://youtu.be/aQtlReciIN0

We are now unveiling a video on YouTube that helps illustrate how anthro head anatomy will work, and how it can be accomplished in real life.

We're using this special issue of our newsletter to bring you up to date on the research and analysis steps we took to get here - so many things have come together! - and also taking you behind the scenes for how we made the video itself.

Before getting into those details, though… we encourage you to check out the video. It's been getting great feedback so far. We think you'll enjoy it and find it interesting!

From the video description on YouTube:
Can we get furries IRL? :3 More seriously, will it become possible for people with species identities other than human to get species-affirming procedures some day?

We understand enough of the biology and technical methods to be comfortable answering “yes, absolutely, some day.” There’s still a lot of work to be done, and we’re doing our part to make it happen within our lifetimes.

We are kicking off a video series that analyzes the head of an anthro (anthropomorphic creature) - how it would work, what it would look like, how it differs from a human’s head, and the methods that would be used during species affirmation procedures.

In this video, we’re focusing on the anatomy and physiology of an anthro wolf’s head. Checking whether we can achieve a satisfactorily species-affirming result. Balancing physiological needs and constraints. Comparing features with quadrupedal animals. And identifying a few key changes needed in the anatomy that will be followed up on in greater detail later in a later video. We believe this video goes a long way to answering the key questions that would have to be answered before detailed wet-lab and preclinical research into species-affirming procedures takes place.

The analysis, including 3D model development, was performed by Lathreas and Zennith. Development of the 3D models involved addressing physiological concerns and constraints, making many design choices along the way, and a large amount of looking at photos and anatomical references. We took inspiration from existing systems in humans and quadrupedal animals, and exercised judgment in whether choices in a given system should more closely follow quadrupeds, or humans, or a mix. It was more work than we expected, but a lot of fun, and we’re excited to be able to share it with you!

One or two followup videos are planned later in 2024, that cover differences between a human’s head and an anthro’s, and the technical methods in consideration. (One or two videos depending on what flows the best).

We are extremely thankful to our community members and supporters on Patreon for helping make this work possible. Huge thanks to UrbanFox and their fox Nora for the videos they provided, and to Articca for putting us in touch with them; and to Hadynpark for several rounds of feedback during video production.

If you would like to learn more, or are curious about joining our community, please check out https://freedomofform.org/. And if you would like to support us on Patreon, our page is at https://www.patreon.com/freedomofform. Thank you for the consideration, and of course, thank you for watching!

Modeling the head to determine feasibility and prioritize research

By Zennith | March 20, 2024

This article talks about the anthro wolf head model, featured in our video, and our research goals with the model.

The importance of understanding head anatomy to our goals

What are the biggest challenges in the way of making it possible for people with nonhuman species identity to take on a more suitable form?

Challenges associated with head anatomy have always been near the top of our list. There's certainly other challenges in other anatomical regions (check out https://freedomofform.org/research/tech-roadmap/ for more details). But, unlike other regions, there are some constraints associated with the head that, if those constraints conflicted with goals or objectives, attempting to engineer solutions around those constraints could potentially add years or decades to our timelines.

Clever engineering can resolve challenges with the tail, or achieving a nice fur coat, even if biology isn't cooperative at first. But clever engineering couldn't help much if, say, we had identified that an acceptable head shape required...ahem...smushing the brain into a different shape. :P

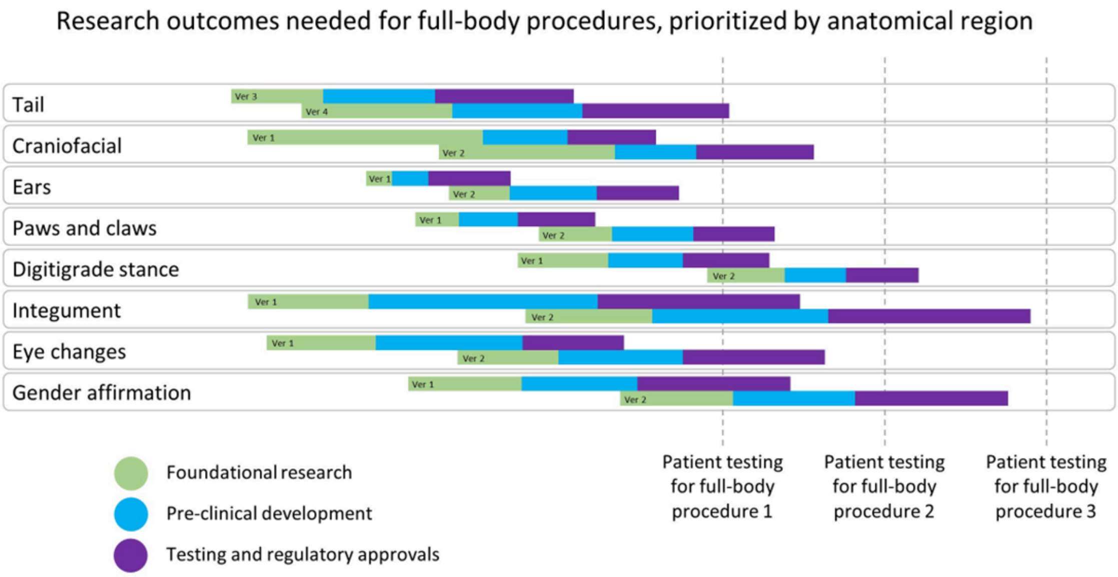


Illustration of how we will be prioritizing our research projects according to region of anatomy. Each of 8 anatomical regions will have an iterative series of projects, proceeding from foundational research, through preclinical development, to clinical testing and any relevant regulatory approvals.

Note how craniofacial research has an early start – around the same time as the tail, integument, and eye changes. This is because we view it as a potentially rate-limiting factor.

So, head size and shape, and several other physiological and aesthetic considerations, have been crucial for us to understand, balance constraints, and work towards a realistic model of an anthro wolf. For example, we needed to know whether eyes would be advanced forwards on the face (and thus, whether the optic nerves would need to be longer). We needed to begin understanding how speech could function with a longer muzzle. And we needed to understand how outer ears transmit sound to the inner ear - was it even possible to get ears on top of the head? You can imagine considerations like the above will have major impacts on what research we choose to perform in the coming years!

This is why we took this modeling so seriously. Physiological needs, ranging from size of the airways, to oral and lip musculature for speech, to the shapes of ears and ear canals, to facial musculature, were considered. The needs to not just avoid the uncanny valley, but faithfully represent a person's identity, were included. And we used as much input as possible from not just general anatomical references, but some real medical scan data as well, to ensure our model was grounded in reality.

Our recent work on head anatomy

In 2022, we started our efforts of building serious craniofacial models covering the bones as well as a photorealistic model of a wolf that included fur and eyes. We initially covered these in our May 2022 and June 2022 newsletters. We were encouraged by initial results that suggested the main constraints we were concerned about, including braincase size and shape, appeared to not conflict with aesthetic goals.

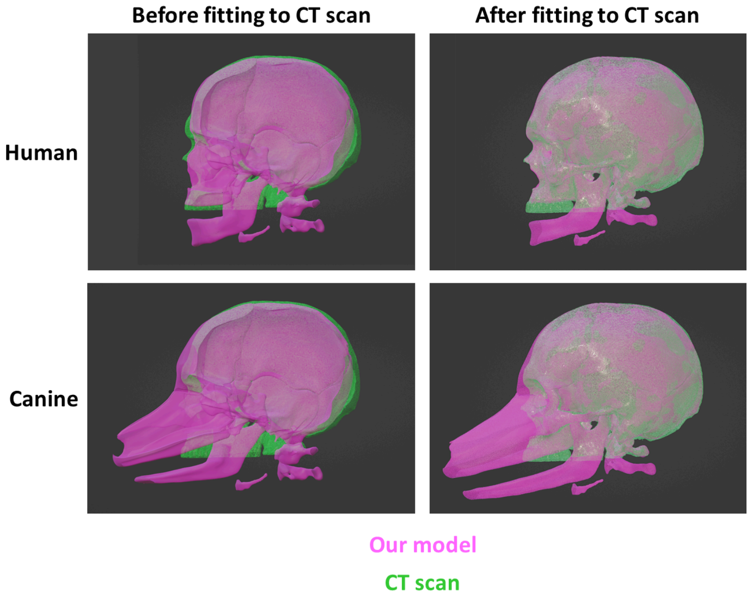
However, the models were still at an early stage. The bone model was only based on general anatomy references at the time (rather than real medical scans). Whereas, for the photorealistic wolf model, Lathreas continued to seek feedback on choices being made, and how they impacted the wolf's aesthetics (and avoid an uncanny appearance). As well, the bone and photorealistic models were developed independently at first, and had differences that were not yet reconciled.

We continued working on the head models in the background. In July 2023, Lathreas wrote a great newsletter article for us that more specifically talked about optic nerve lengthening, which our 2022 work had already suggested was likely necessary.

Then, in the final months of 2023, we had the idea of putting together a video (series) covering head anatomy (announced in our November 2023 newsletter). Details about the first video's production are in the article that follow this one, for those who are curious!

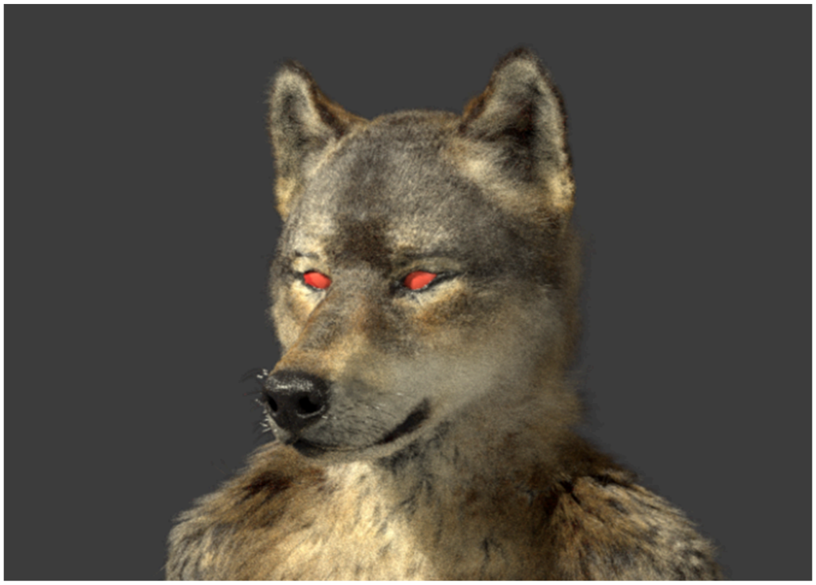
The video project was a good nudge for us to finish the modeling, get it as scientifically strong as we could, and reconcile the bone-focused and photorealistic models.

In December 2023, I presented the main improvements to the bone model. The improvements amounted to fitting the basic bone model (again, initially based on general anatomy references) to a real CT scan. Check out the before-and-after, where the magenta skulls are our model, and the green skulls are the real CT scan. Overlapping colors indicate proper alignment.



The most important conclusions we had made from 2022 stood up to time. However, there were some details, such as in the pharyngeal area, where we wondered what kinds of anatomical modifications would be needed, if any. The updated, late-2023 model allowed us to answer those questions!

Our December 2023 article on this is quite detailed. We were able to resolve our questions about the pharyngeal area, for example: “it appears that the underside of the temporal, sphenoid, and occipital bones do not need modified for a successful anthropomorphic transition”.



The state of our model in December 2023. Mostly great! But sorry for the demon eyes. In January, Lathreas fixed this issue and made several more substantial improvements!

Additionally, I presented a first attempt at reconciling Lathreas’s photorealistic* wolf model with the bones. We wanted to make sure that the proposed head shape, that we had matched to the medical scan.

(*Lathreas’s version is photorealistic, but to be honest, I messed up the render settings somehow and wound up with a wolf with demon eyes. Aside from *that*, the wolf looked great!)

In January 2024’s Craniofacial Special, Lathreas unveiled significant improvements to the muzzle shape and how it blends into the forehead. They also wrote an article going into more details about the constraints we were balancing with this modeling.

Lathreas elucidated several of the constraints that we were tracking. Braincase size, as mentioned above. But also, things like: eyeball size and shape. The eye’s alpha angle (basically, the direction the eye is pointed). The position of the jaw’s condyle. And unmodified airflow in the airways.

After the January article, we went through some small additional edits, mostly editing the mandible and maxilla to improve the snout shape just a little bit more. But then that was it!

We had it. We had figured out what the head of an anthro wolf could really be like, looking (and feeling) totally natural, while satisfying the most important constraints and physiological concerns we could think of.

I know I’ve mentioned this already to several people, and I’m sorry if this is repetitive, but I literally cried when Lathreas showed me their model. It was a moment of “oh my god that is a *wolf* and I *know the physiology works*”. It was amazing and I’ll treasure that moment forever.

This model represents a complete first version of planned anthro head anatomy
The most important outcome of this work, so far, has been the determination that an anthropomorphic head shape is achievable within the constraints we set.

The model encapsulates our professional opinions on our consideration of constraints, tradeoffs, knowledge of relevant anatomical features, expectation of physiological function, and aesthetic quality. The model has been reconciled into something that is fully self-consistent and comprehensive within its scope.

As a complete version, this also implies that the next time our researchers need to update the model, the change will need to be justified, and handled with a sufficient form of change control. Example reasons to update the model include adding a new tissue type, or improving the accuracy of muscles. Changes to the model, and customizations, are intended as future directions.

How we'll prioritize research based on the model
The next most important use of the model is to guide our choices in prioritizing research.

A complete head model gives us objectives about the tissues that will need changed, and the degree to which they will need changed. This means that we can make highly directed judgements about the types of research we prioritize, ranging from computational or wet-lab to preclinical, clinical, and surgical studies.

It is a meme in scientific literature to say that 'more research is needed' or that 'some particular new knowledge may be useful to a medical application'. To be clear, I don't have an issue with statements like that: basic and research are essential and have made many of the best parts of our modern world possible. But we have specific objectives in mind; we aim to engineer functional systems. A basic science approach is insufficient for our goals.

Based on this work, there are a few areas that may become priorities for us to research.

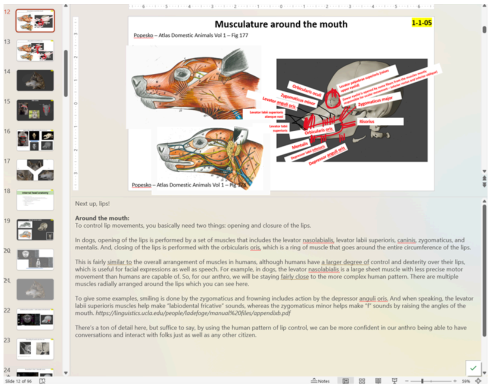
Some of the things that come to my mind are: Optimizing the modification of optic nerve length. Ear muscle control (which may piggyback off the tail neuroprosthetic project). Length of other nerves in the face, like the facial nerve. Choosing methods of lengthening the maxilla and mandible, whether implant, or distraction osteogenesis, or a mix, or some other technique. Modifying iris appearance. And potentially, controlled enlargement of muscles of the lips and oral cavity, if passive/gradual enlargement is insufficient.

We still have more homework to do on that prioritization. Our model is still hot off the press, after all!

Behind the scenes: production of the video

By Zennith | March 21, 2024

From A-roll to Zero RAM remaining (Aaaaaa!!!) when working in Blender, and everything in-between



Musculature around the mouth

1-1-05

Popesko – Atlas Domestic Animals Vol 1 – Fig 177

Popesko – Atlas Domestic Animals Vol 1 – Fig 178

Next up, lips!

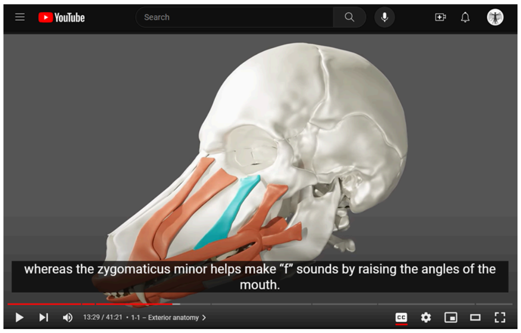
Around the mouth:
To control lip movements, you basically need two things: opening and closure of the lips.

In dogs, opening of the lips is performed by a set of muscles that includes the levator nasolabialis, levator labii superioris, caninis, zygomaticus, and mentalis. And, closing of the lips is performed with the orbicularis oris, which is a ring of muscle that goes around the entire circumference of the lips.

This is fairly similar to the overall arrangement of muscles in humans, although humans have a larger degree of control and dexterity over their lips, which is useful for facial expressions as well as speech. For example, in dogs, the levator nasolabialis is a large sheet muscle with less precise motor movement than humans are capable of. So, for our anthro, we will be staying fairly close to the more complex human pattern. There are multiple muscles radially arranged around the lips which you can see here.

To give some examples, smiling is done by the zygomaticus and frowning includes action by the depressor anguli oris. And when speaking, the levator labii superioris muscles help make "labiodental fricative" sounds, whereas the zygomaticus minor helps make "f" sounds by raising the angles of the mouth. *https://linguistics.ucla.edu/people/ladefoge/manual%20files/appendixb.pdf*

There's a ton of detail here, but suffice to say, by using the human pattern of lip control, we can be more confident in our anthro being able to have conversations and interact with folks just as well as any other citizen.



whereas the zygomaticus minor helps make "f" sounds by raising the angles of the mouth.

The left picture shows a screenshot of one of the slides in the document I used to plan concepts and draft the script, November 2023. It's messy! And on the right is the finished product, March 2024.

It took a lot of work to get from a concept, to a draft script, to various stages of production and assembly, to the final cut!

We started working on the video in October 2023 and wrapped up this month, March 2024.

A frame from the first draft video in February, 2024. The wolf is trying really hard, go easy on them! :<

In October, we started outlining the concepts of the video (as well as the concepts that will be included in the followup video(s) of the video series). In addition, Articca put us in contact with UrbanFox, who provided us several amazing video recordings of Nora such as those featured in the video. I definitely replayed those videos more than a few times. They were cute. @.-.@

We mostly drafted the script in November, and took a first test recording to check timing and flow, but had a fair bit more work to do with the visuals (mainly updating the anatomy model described in the article above). Some of our community members, including Hadynpark, listened to the recording at this stage and helped us out a lot with what to emphasize and clarify.

We spent lots of time that December getting the bones into shape, then adding muscles for both the human and wolf models. In January, Lathreas and I focused on merging and reconciling our models.

Starting in early February, I was able to get back to revising the script. I did a second test recording, made some small changes to improve the flow, and… was pretty well happy with the content by that point! With the script all set, and the main visual assets ready to go, it was time to shift from "think" to "do".

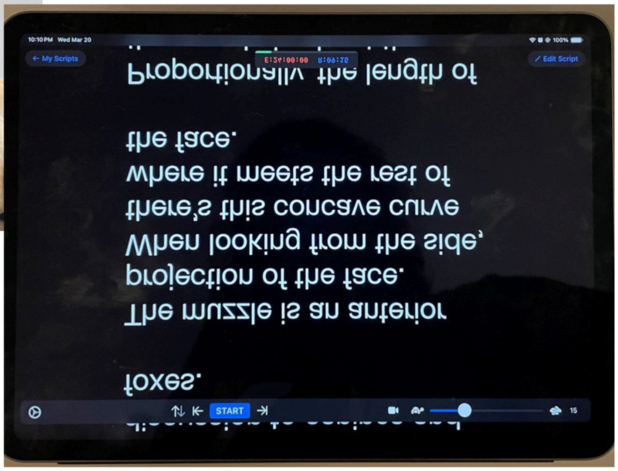
I started drafting, then polished, several scientific illustrations according to the previous plans. Also, I spent some time adding animations to the wolf 3D model*, like camera movements, and color changes to emphasize anatomical parts when they're mentioned.

**Technically, all of these animations were applied to a fork of the wolf 3D model. We didn't want to mess with our authoritative version 1 model for this.*

I arranged these in the first true draft of the video, as opposed to simply draft audio recordings accompanied by a messy PowerPoint.

In the middle of February, I took a couple days of Paid Time Off from my day-job to film the A-roll. This involved figuring out a good place to film (the couch worked perfectly! It was tidy, comfy, and professional, all in one), setting up lights and a teleprompter, and using my phone as a video camera behind the teleprompter. In addition, I captured several angles of a dog skull specimen, forming part of the B-roll.

Left: me scrolling the script on the teleprompter to the top before starting an A-roll take.



Right: Teleprompter app on my iPad. When placed under the reflector/one-way mirror of the teleprompter equipment, the words become (more easily) readable.

With the A-roll ~~in hand~~ in paw, it was time to start rendering.

With how much work everything had taken so far - several hundred hours of work by this point - and with how nice the project was turning out so far, I wanted the renders to be just as good as everything else in the video. To cap the renders below their potential, at the end of the project, would be unthinkable. So. Render at 4k resolution, using the Cycles engine in Blender.

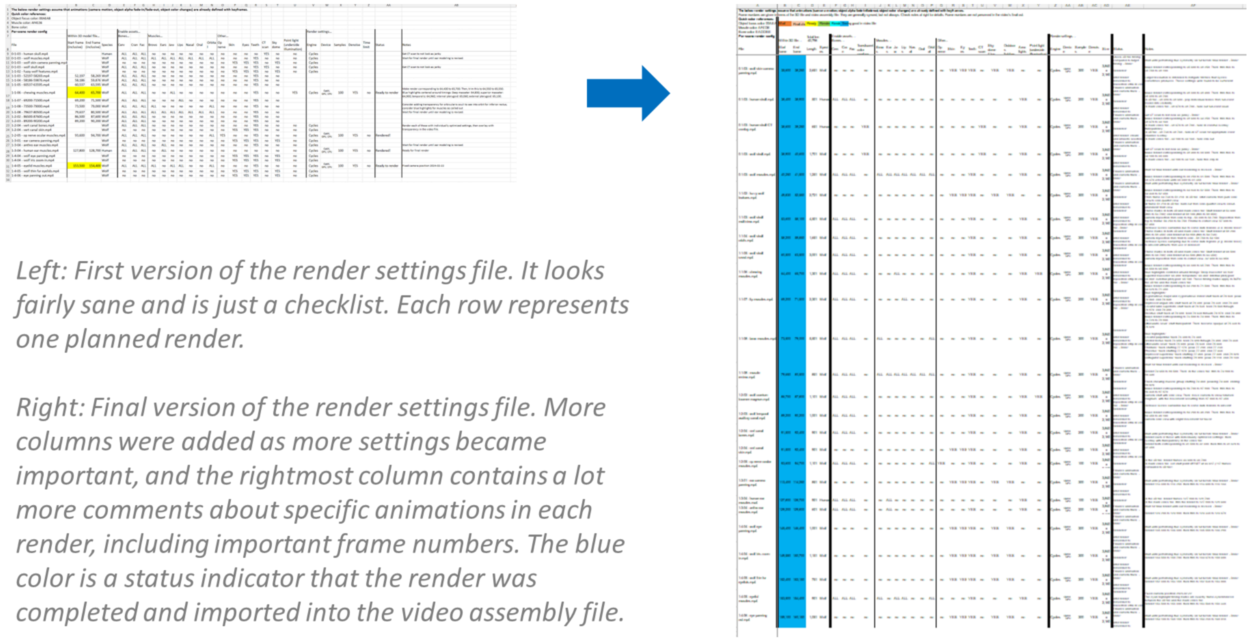
Using my laptop for the first render, it was...slow. The first render was one of the easiest renders out of the set of 26 renders needed, and it took something like 2 or 3 days to finish. Not that my laptop is a wimp...it's just the renders really were that involved.

So, I made just about the fastest big purchasing decision I've ever gone through.* Before the first render had even finished, I had decided to buy a standalone desktop rendering PC. By that Wednesday, February 21st, I'd ordered all the parts I needed including an RTX 4090 video card. And...yeah, 128 GB of RAM. I received the parts on Friday and Saturday, spent the weekend being unusually paranoid about static and grounding myself, and by the Sunday of February 25th, mid-afternoon, that PC was roaring into the next renders needed for the project!

The computer's name is Chromatic Dragon, by the way. That was the name proposed by my partner, Sharu, and it stuck. ^.-.^

**I bought this PC using personal money, NOT organization funds. I still wasn't sure at the time that the investment would be worth it. And...also I might want to use the PC for personal gaming too. :3*

Managing the renders and keeping them organized turned out to be pretty involved. There were bones and muscles that had to be enabled or disabled, for the human or wolf model. Different sets of lights, and the background image, had to be configured for each scene. And even animation timings (e.g. when the blue flashes for muscles being mentioned) had to be written down, to coordinate their timing between the A-roll audio recording and the 3D animation file. So...a file in Excel started to emerge, and gradually became a behemoth.



Left: First version of the render settings file. It looks fairly sane and is just a checklist. Each row represents one planned render.

Right: Final version of the render settings file. More columns were added as more settings became important, and the rightmost column contains a lot more comments about specific animations in each render, including important frame numbers. The blue color is a status indicator that the render was completed and imported into the video assembly file.

A couple weeks later, the renders were done. If I had still been using my laptop, we'd probably still be waiting another 2 months. So… the new PC was a good call!

Some relatively minor editing later, and getting some additional helpful feedback from people, the video was done! Add in a YouTube thumbnail image and description, and referencing our sources, and that was it!

This took a lot of work, and I am very proud of the result. I'm actually just about as proud of this as I felt after defending my PhD thesis. Maybe more proud. Because… this project has pushed me in so many different ways, scientifically and creatively, and this was for something that is important to not just me personally, but vitally meaningful to so many of my friends. This work matters, and I know I've given it my absolute best.

The head anatomy video series isn't done. But this was my first ever serious video I've produced. Also, the work that went into the wolf model only needed to be done once, since the later videos in the head anatomy series will take different and closer looks at the same model. The followup in the series will still take a lot of work, but this first video is unconditionally something we can be proud of.

I am sincerely thankful to our volunteers, community members, and to our supporters on Patreon. And I am especially thankful to Lathreas for helping me out at every step of the process. Hadynpark not just for the helpful comments, but being encouraging and helping me stick with the project from the very beginning. Articca and UrbanFox for their help with Nora's videos of course, but also being awesome. (And Articca also helped me avoid a mistake when I was ordering an AIO cooler for the rendering PC's CPU!) And finally, to my partner Sharu for tolerating Chromatic Dragon's roar over the weeks while it was rendering day and night.